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March 30, 1999

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In accordance with the terms of the Office of Naval Research Grant No. N00014-96-1-0484, I am sending you the following material:

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Thank you. Please contact me if you have any questions or comments.

Mary S. Greene  
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cc: Prof. Kleppner (1)  
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QUANTUM CHAOS IN RYDBERG ATOMS  
January 1, 1998- December 31, 1998  
Daniel Kleppner, Principal Investigator

ANNUAL TECHNICAL REPORT

We have carried out a study of physics in the semiclassical regime. Recently we extended the technique of recurrence spectroscopy to the time domain. This work has been published in

"Extracting classical trajectories from atomic spectra," M.R. Haggerty, and J.B. Delos, Neal Spellmeyer and Daniel Kleppner, Phys. Rev. Lett. 81, 1592-1595 (1998).

In a separate experiment we investigated extending the semiclassical closed orbit theory to a process whose origin is entirely quantum mechanical: tunneling. We studied the continuum photoexcitation spectrum of Rydberg states of lithium in an electric field under conditions for which the escaping electron must tunnel through the potential barrier, and also for which it could escape over the barrier. We applied scaled energy spectroscopy to the system, making it possible to relate the spectrum to the classical orbits. When tunneling is important, new classical orbits can originate by an entirely non-classical process. It has turned out to be possible to understand the system theoretically and reproduce the spectrum in great detail, including both sharp tunneling resonances and broad above-barrier structures. The work is being prepared for publication in the paper

"Recurrence Spectroscopy of Above-Barrier States," Vladimir Kondratovicheh, John. B. Delos, Neal Spellmeyer and Daniel Kleppner, to be published.

## ATTACHMENT NUMBER 1

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